

## CLAIMS

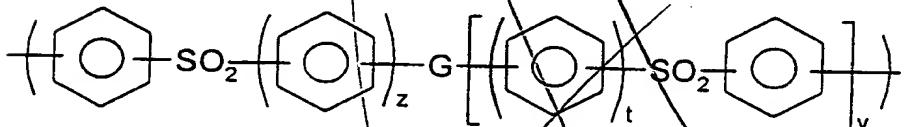
1. A polymer electrolyte membrane which includes a  
5 polymer having a moiety of formula



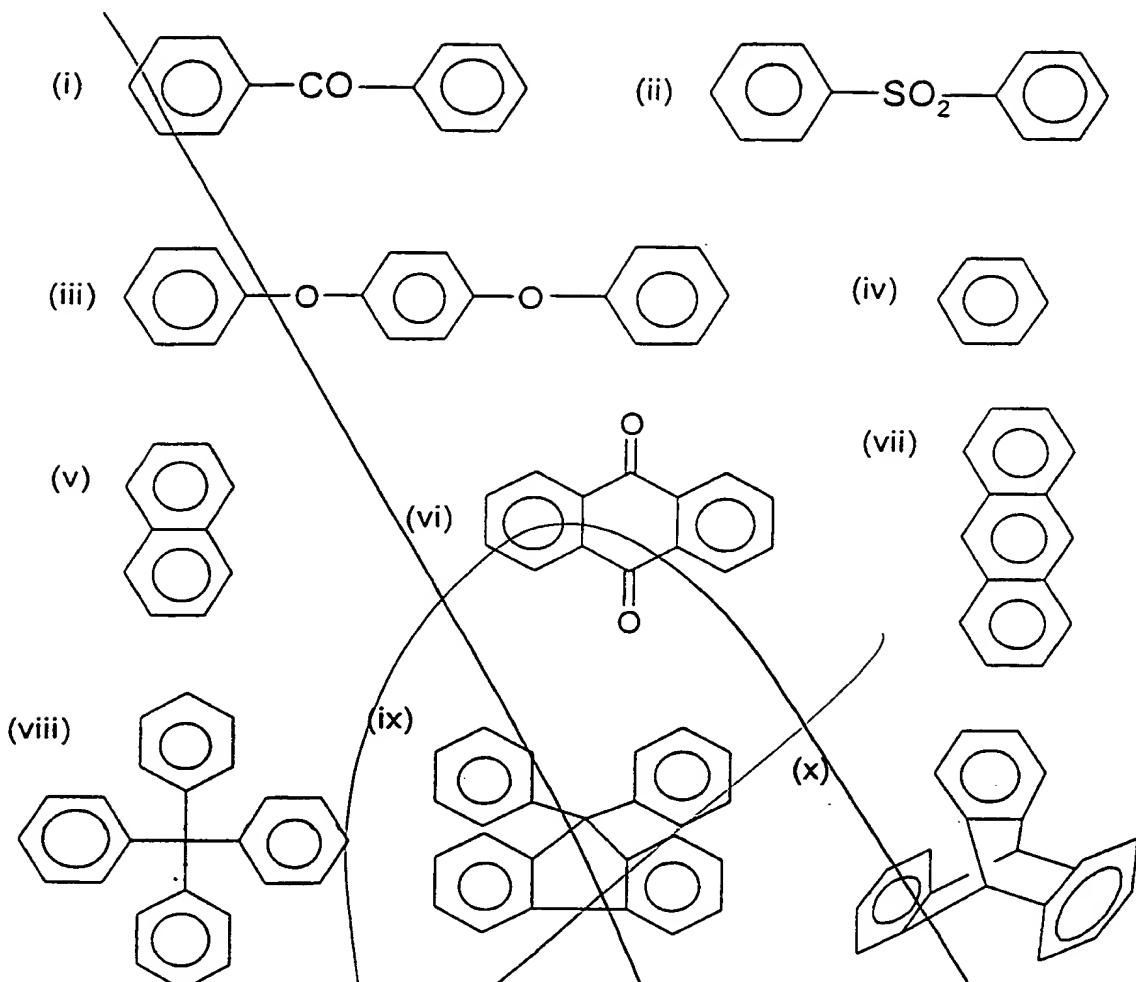
and/or a moiety of formula



10 and/or a moiety of formula



wherein at least some of the units I, II, and/or III  
15 are sulphonated; wherein the phenyl moieties in units I,  
II and III are independently optionally substituted and  
optionally cross-linked; and wherein m,r,s,t,v,w and z  
independently represent zero or a positive integer, E and  
E' independently represent an oxygen or a sulphur atom or  
a direct link, G represents an oxygen or a sulphur atom, a  
direct link or a  $-\text{O}-\text{Ph}-\text{O}-$  moiety where Ph represents a  
20 phenyl group and Ar is selected from one of the following  
moieties (i) to (x) which is bonded via one or more of its  
phenyl moieties to adjacent moieties



2. A polymer electrolyte membrane which includes a polymer having a moiety of formula I and/or a moiety of formula II and/or a moiety of formula III as described in claim 1, wherein at least some of units I, II and/or III are functionalized to provide ion exchange sites.

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3. A membrane according to claim 1 or claim 2, wherein said polymer is crystalline.

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4. A membrane according to any preceding claim, wherein "a" represents the mole % of units of formula I in said

polymer; "b" represents the mole % of units of formula II in said polymer; and "c" represents the mole % of units of formula III in said polymer and wherein a is in the range 45-100 and the sum of b and c is in the range of 0-55.

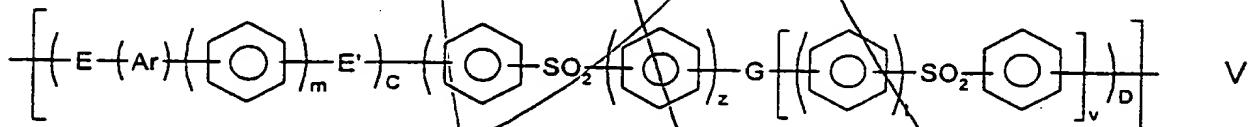
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5. A membrane according to any preceding claim, wherein said polymer consists essentially of moieties I, II and/or III.

10 6. A membrane according to any preceding claim, wherein said polymer is a homopolymer having a repeat unit of general formula



15 or a homopolymer having a repeat unit of general formula



or a random or block copolymer of at least two different units of IV and/or V

20 wherein A, B, C and D independently represent 0 or 1.

7. A membrane according to claim 6, wherein said polymer includes at least one repeat unit of formula IV.

25 8. A membrane according to claim 6, wherein said polymer is a copolymer comprising a first repeat unit of formula

IV wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (iv), m represents 1, w represents 1, s represents zero, A and B represent 1; and

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a second repeat unit of formula V wherein E and E' represent oxygen atoms, Ar represents a structure (i), m represents 0, C represents 1, z represents 1, G represents a direct link, v represents 0 and D represents 1.

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9. A membrane according to claim 6, wherein said polymer is a copolymer comprising a first repeat unit of formula IV, wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (iv), m represents 1, w represents 1, s represents 0, A and B represent 1.

10. A membrane according to claim 6, wherein said polymer is a copolymer comprising a first repeat unit of formula IV wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (iv), m represents 1, w represents 1, s represents 0, A and B represent 1; and a second repeat unit of formula IV wherein E represents an oxygen atom, E' represents a direct link, Ar represents a moiety of structure (i), m represents zero, A represents 1, B represents 0.

11. A membrane according to claim 6, wherein said polymer is a copolymer comprising a first repeat unit which is either:

(a') of formula IV wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a

moiety of structure (iv), m and s represent zero, w represents 1 and A and B represent 1; or

5 (b') of formula IV wherein E represents an oxygen atom, E' represents a direct link, Ar represents a moiety of structure (i), m represents zero, A represents 1, B represents zero;

10 and a second repeat unit which is either:

15 (c') of formula IV wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (iv), m represents 1, w represents 1, s represents zero, A and B represent 1; or

20 (d') of formula IV wherein E represents an oxygen atom, E' is a direct link, G represents a direct link, Ar represents a moiety of structure (iv), m and s represent zero, w represents 1, A and B represent 1.

25 12. A membrane according to claim 11, wherein said polymer has a repeat unit as described in paragraph (a') or (b') in combination with a repeat unit as described in paragraph (c').

30 13. A membrane according to claim 6, comprising a first repeat unit which is selected from the following:

(a) a unit of formula IV wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (iv), m and s represent zero, w represents 1 and A and B represent 1;

(b) a unit of formula IV wherein E represents an oxygen atom, E' represents a direct link, Ar represents a moiety of structure (i), m represents zero, A represents 1, B represents zero;

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(c) a unit of formula V wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (iv), m and v represent zero, z represents 1 and C and D represent 1;

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(d) a unit of formula V wherein E represents an oxygen atom, E' represents a direct link, Ar represents a moiety of structure (ii), m represents 0, C represents 1, D represents 0; or

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(e) a unit of formula V wherein E and E' represents an oxygen atom, Ar represents a structure (i), m represents 0, C represents 1, Z represents 1, G represents a direct link, v represents 0 and D represents 1;

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and a second repeat unit which is selected from the following:

(f) a unit of formula IV wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (iv), m represents 1, w represents 1, s represents zero, A and B represent 1;

(g) a unit of formula IV wherein E represents an oxygen atom, E' is a direct link, G represents a direct link, Ar represents a moiety of structure (iv), m and s represent zero, w represent 1, A and B represent 1;

(h) a unit of formula V wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (iv), m represents 1, z represents 1, v represents 0, C and D represent 1; and

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(i) a unit of formula V wherein E represents an oxygen atom, E' represents a direct link, G represents a direct link, Ar represents a moiety of structure (iv), m and v represent zero, z represents 1, C and D represent 1;

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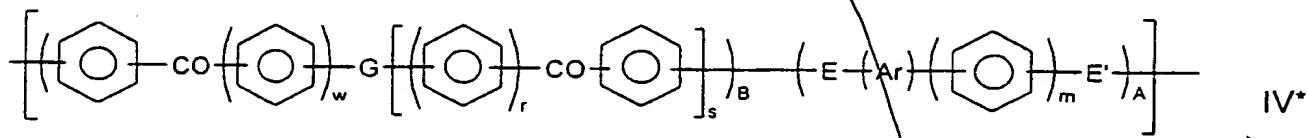
14. A membrane according to any of claims 6 to 13, wherein said second unit is selected from a unit of formula IV wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (v), m represents 0, w represents 1, s represents 0, A and B represent 1; or a unit of formula V wherein E and E' represent oxygen atoms, G represents a direct link, Ar represents a moiety of structure (v), m represents 0, z represents 1, v represents 0, c and d represent 1.

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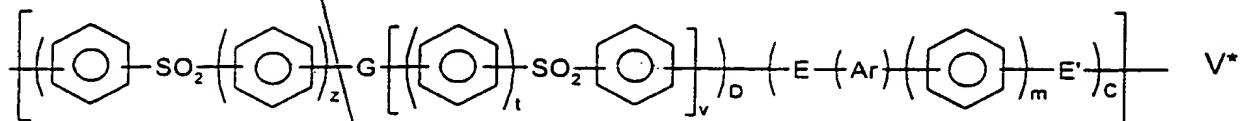
15. A membrane according to claim 13 or claim 14, wherein said copolymer has a first repeat unit selected from units (b), (d) or (e) in combination with a second repeat unit selected from units (f) or (h).

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16. A membrane according to any of claims 1 to 5, wherein said polymer is a homopolymer having a repeat unit of general formula



or a homopolymer having a repeat unit of general formula



5 or a random or block copolymer of at least two different units of IV\* and/or V\* wherein A, B, C and D independently represent 0 or 1.

17. A membrane according to claim 16, wherein said polymer includes: a repeat unit of formula IV\* wherein E represents a direct link, E' represents an oxygen atom, G represents a direct link, w, s and m represent 0, A and B represent 1; and/or a repeat unit of formula V\* wherein E represents a direct link, E' represents an oxygen atom, G represents a direct link, z, v and m represent 0, C and D represent 1.

18. A membrane according to claim 17 which includes a repeat unit of formula IV\* or V\* and any of units (a) to (i) according to claim 13.

19. A membrane according to any preceding claim, wherein said polymer includes at least some ketone moieties in the polymeric chain.

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20. A membrane according to any preceding claim, wherein said polymer includes a biphenylene moiety.

21. A membrane according to any preceding claim, wherein  
said polymer includes a -O-biphenylene-O- moiety.

22. A membrane according to any preceding claim, wherein  
5 said polymer includes a -O-naphthalene-O-moiety.

23. A membrane according to any preceding claim, wherein  
said polymer has a glass transition temperature (Tg) of at  
least 144°C.

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24. A membrane according to claim 23, wherein said glass  
transition temperature is at least 154°C.

25. A membrane according to any preceding claim, wherein  
15 said polymer has an inherent viscosity of at least 0.3.

26. A membrane according to any preceding claim, for a  
fuel cell.

20 27. A membrane according to any preceding claim, for an  
electrolyser.

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28. A fuel cell incorporating a polymer electrolyte  
membrane according to any of claims 1 to 25.

29. An electrolyser incorporating a polymer electrolyte  
membrane according to any of claims 1 to 25.

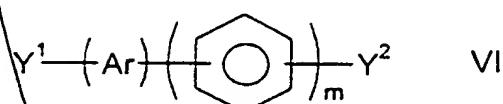
30. A gas diffusion electrode incorporating a polymer  
electrolyte membrane according to any of claims 1 to 25.

31. A novel polymer as described in any of claims 1 to 25  
per se.

32. A process for the preparation of a polymer as described in any of claims 1 to 25, the process comprising:

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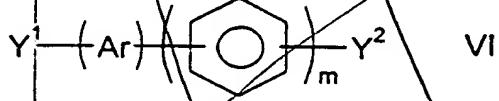
(a) polycondensing a compound of general formula



with itself wherein Y¹ represents a halogen atom or a group -EH and Y² represents a halogen atom or, if Y¹ represents a halogen atom, Y² represents a group E'H; or

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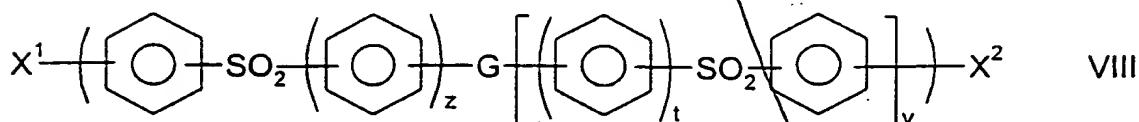
(b) polycondensing a compound of general formula



with a compound of formula



and/or with a compound of formula



wherein  $Y^1$  represents a halogen atom or a group  $-EH$  (or  $-E'H$  if appropriate) and  $Y^2$  represents a halogen atom or a group  $-E'H$  and  $X^2$  represents the other one of a halogen atom or a group  $-E'H$  (or  $EH$  of appropriate); and

(c) optionally copolymerizing a product of a process as described in paragraph (a) with a product of a process as described in paragraph (b);

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wherein the phenyl moieties of units VI, VII and/or VIII are optionally substituted; the compounds VI, VII and/or VIII are optionally sulphonated; and Ar, m, w, r, s, z, t, v, G, E and E' are as described in any of claims 1 to 20 except that E and E' do not represent a direct link; the process also optionally comprising sulphonating and/or cross-linking a product of the reaction described in paragraphs (a), (b) and/or (c) to prepare said polymer.

20 33. A process according to claim 31, wherein sulphonation  
is carried out in concentrated sulphuric acid at an  
elevated temperature.

34. A novel polymer as described in any of claims 1 to 24  
25 (except that the polymer is not sulphonated) *per se*.

35. A membrane, a fuel cell, a process, a novel polymer, each being independently substantially as hereinbefore described, with reference to the examples.